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REVISIONS

Section	Change
Exec. Summary, Recommendations	Additional recommendations added.
1.6 Study members	List amended.
3.2 Study breakdown	Corresponding P&IDs to IPFs amended.

HOLDS

Hold No.	Section	Description

ABBREVIATIONS

C&E	Cause & Effect Diagram
EGPC	Egyptian General Petroleum Company
IL	Integrity Level
IPF	Instrumented Protective Function
EPC	Engineering, Procurement & Construction
ESD	Emergency Shut Down
F&G	Fire and Gas
FEED	Front End Engineering Design
GOGC	Genesis Oil and Gas Consultants Ltd
HAZOP	Hazard and Operability
HP/LP	High Pressure / Low Pressure
HS&E	Health, Safety and Environmental
KPC	Khalda Petroleum Company
LOPA	Layers Of Protection Analysis
P&ID	Piping and Instrumentation Diagram
PFD	Probability of Failure on Demand
PMC	Project Management Contractor
PSV	Process Safety Valve
SAMS	Safety Action Management System
SOL	Start Of Line
SIL	Safety Integrity Level
SIMOPS	Simultaneous Operations
TOR	Terms Of Reference

EXECUTIVE SUMMARY

General

GOGC has carried out FEED studies for the new Qasr facilities, including a Safety Integrity Level (SIL) assessment study to establish the SIL required for each of the 54 Instrumented Protective Functions (IPFs). The study was an extension of the preceding HAZID study (Ref. 1) and HAZOP study (Ref. 2). The P&IDs and the Cause & Effects diagrams were used as the primary / master documents for the SIL Assessment. Each IPF was reviewed by considering the potential safety, environmental and financial risk using the risk graph approach in accordance with IEC 61511.

The aim of this report is to document the findings of the SIL workshop. Achievement of the SIL targets established in this report will need to be demonstrated during detailed design once the systems have been more fully defined.

This review should be considered preliminary as it has been performed at the FEED stage of the project and there may be changes as the design is developed and refined during detail engineering. The findings of this FEED review, and the assumptions that are summarised in Table 3-4 should be revisited and reviewed during detail engineering.

Main Findings

A total of 54 IPFs were identified as part of the SIL assessment. The breakdown of classifications is shown in Table 1.0.

Table 0-1.0: Summary of SIL Classifications

Classification	No. of IPFs	Comments
SIL 4	0	None
SIL 3	0	None
SIL 2	13	The majority are financial, arising from failure of one or more compressors, or the HP fuel gas supply on which they depend.
SIL 1	19	The majority of these are also financial.
SIL 0 (or unclassified)	22	These are IPFs which are conventionally expected in a HAZOP, but which do not provide a substantial reduction in risk.
Total IPFs Reviewed	54	

A listing of IPFs in each classification, along with the consequence category driving the overall classification, is given in Tables 4-2 to 4-5.

Recommendations

One recommendation was made during the SIL assessment:

1. Consider providing separate initiators on duties where the same instrument provides input into two distinct outputs under two distinct initiating conditions;
2. Any SIL 2 or higher shall be confirmed during detailed design using a more quantitative approach, e.g. Fault Tree Analysis;

3. Changes to the design basis shall require re-assessment
4. EPC contractor shall verify IPF (30-LIT-344 HH) on the existing HP Flare KO Drum to confirm SIL 2 classification

1 INTRODUCTION

1.1 Project Background

Qasr is a large, normally pressured gas-condensate reservoir located in the Western Desert of Egypt approximately 525 km west of Cairo. The field is operated by Khalda Petroleum Company (KPC), a joint venture between Apache Corporation and Egyptian General Petroleum Company (EGPC).

Figure 1-1 Qasr Development Location

Field production is initially handled at the Start of Line (SOL) Qasr Plant. After initial treatment (cooling and water removal) the gas/condensate is exported to a combination of the Salam, Tarek and Obaiyed gas plants for further treatment.

The Qasr gas and condensate currently free flows from the wellheads through the Qasr Phase I and Phase II facilities and export pipelines to the SHAMS manifold and Salam gas plant under reservoir pressure. As the reservoir pressure declines the peak gas rate of 800 mmscfd will no longer be achieveable. The Qasr Compression Project is designed to improve recovery as the reservoir production rate and pressure decline.

The Qasr Compression Project scope comprises:

- Gas turbine driven single stage compressor sets
- Condensate export pumps
- Power generation
- Utility systems

1.2 Purpose

This document is the report of the Safety Integrity Level (SIL) workshop for the Qasr Compression Project which was performed shortly after the completion of the HAZOP.

A number of measures are to be used on the Qasr Compression Project facilities to control the process risk (safety, environmental and financial). Some of these measures are to be implemented using Instrumented Protective Functions (IPFs).

The degree of reliance on these IPFs to control the risk to a tolerable level has been established by categorising the Safety Integrity Level (SIL) required for each IPF.

This assessment has been done in line with guidance provided in IEC 61511 (Refs. 3, 4 and 5), and has used the calibrated Risk Graph approach (see Appendix A). This approach relies on grading a number of parameters that describe the nature of the incident and its potential impact on risk:

- Consequence severity (no. of people affected & vulnerability);
- Personnel exposure;
- Alternatives to avoid danger; and
- Environmental impact; and
- Consequential loss of assets or revenue; and
- Demand rate.

The grading has been carried out without taking credit for the IPF so that the criticality of the IPF could be established.

1.3 Pre-Requisites

The study has applied the Risk Graph approach in IEC 61511 to the new Qasr facilities. The Risk Graph in IEC 61511 has been accepted by KPC for the risk control requirements.

1.4 Review Basis

This initial review has been performed at the FEED stage of the project. It is anticipated that the design will be developed and refined during detail engineering, and the findings will need to be revisited during detailed design.

The master HAZOP P&IDs and ESD Cause & Effects Diagram that form the basis of the SIL assessment are included in Appendices B and C respectively.

1.5 Timing and Location

The SIL study took place on the 3rd October 2011 in GOGC's offices, High Holborn, London

1.6 Study Members

The personnel attending the SIL review are listed in Table 1-1.

Table 1-1: SIL Review Team Members

	Name	Position
1	Rod Bayliss	SIL Chairman
2	Chris Fossa	Scribe
KPC		
3	Ayman Saleh	Project Manager
4	Mohamed Saleh	Mechanical
5	Ibrahim Hammad	Process
6	Mohamed Ismail	Control & Instrument
7	Moataz Elsalakawy	Project General Manager
PMC		
8	Somu Janarthanan	Process
GOGC		
9	Himanshu Mohorikar	Process
10	Paul Small	Control & Instrument (Part-time)
11	Russ Jenkins	Safety
12	Daniel Palen	Process

2 SCOPE & APPROACH

2.1 Study Scope

2.1.1 Inclusions

The review has assessed all the IPFs included in the design of the Qasr Compression Project FEED to protect against, or to mitigate the consequences of, unplanned deviations from normal operating conditions that affect safety, environmental and financial risk from:

- Process Elements;
- Hazardous utilities.

The IPFs have been identified from the ESD Cause and Effect matrices, and cross-checked against the HAZOP and the P&IDs.

2.1.2 Exclusions

Non-hazardous utilities, spurious trip integrity affecting production loss (revealed failures) and loops with manual initiation are not within the scope of this study.

A number of inputs included in the ESD Cause & Effect matrices have been omitted from this review. These include:

- Permissives (e.g. instruments that allow a control action to occur, or prevent a control action from occurring;
- Inputs from the existing Qasr facilities;
- Inputs from the Fire & Gas system on the new facilities;
- Vendor packages (for which no information is shown on the P&ID);
- Spurious trip integrity affecting production loss (revealed failures);
- Loops with manual initiation, e.g. push buttons.

2.2 Study Approach

2.2.1 Overview

This assessment is performed in line with guidance provided in IEC 61511 (Refs. 3, 4 and 5), and has used the Risk Graph approach, as shown in Table 2-1.

Table 2-1: Risk Graph

Risk Graph

Consequence Severity		Personnel Exposure		Alternatives to Avoid Danger (if the protection fails)		Demand Rate	
Slight Injury	SI	Not applicable	NA	Not applicable	NA	High 0.3 - 3yrs	H
Serious Injuries or 1 Death	1D	Rare (<10% of time)	R	Possible	P	Low 3 -30 yrs	L
Multiple Deaths	MD	Frequent	F	Not Likely	NL	Very Low 30 yrs +	VL
Catastrophic	C						
(>10 deaths use quantified)							
		NB: If demand rate is related to occupancy then use F		*P should only be selected if all the following are true:*		*Normal mode of control / cause of demand*	
Environmental	E			1. The operator will know the protection has failed		Operator	H
Financial / Reputation	F			2. Independent means of shutting down are provided		PCS	L
				3. There is sufficient time for the operator to respond prior To the hazardous event occurring.		ESD / SSDS	VL

Consequence Type
SAFETY (S)

			High	Low	Very Low
SI			0	0	0
1D	R	P	1	0	0
		NL	2	1	0
	F	P	2	1	1
		NL	3	2	1
MD	R		3	3	2
	F		4	3	3
C			4	4	4

Consequence Type
ENVIRONMENTAL (E)

Reportable Release	RR	1	0	0
Major temporary environmental impact (up to 3 months)	MT	2	1	0
Major longer term environmental impact (> 3 months)	MP	3	2	1

Consequence Type
FINANCIAL (F)

<$1M	<M	1	0	0
=$1M<$10M	MM	2	1	0
>$10M	>M	3	2	1

Note: If wholly independent mechanical protection (e.g. PSV), or a wholly independent high integrity protection system (HIPS) specified to meet or exceed the requirements of SIL 3, is available and provides total protection against the scenario under consideration, the resulting SIL target for the protective system in question can be reduced by 2.

For example:
SCENARIO: Overpressure protection provided by ESD loop (PT, logic solver and valve) and PSV, either one operating will prevent the hazard occurring.
RISK GRAPH TARGET: SIL target for ESD loop as per the above risk graph is SIL 3.
ACTUAL TARGET: SIL target for the ESD loop taking into account the added protection provided by the PSV is 3 - 2 = SIL 1.
SIL LEVELS: SIL 1 (PFD 0.1 – 0.01); SIL 2 (PFD 0.01 – 0.001); SIL 3 (PFD 0.001 – 0.0001); SIL 4 (PFD 0.0001 – 0.00001).

This approach relies on grading a number of parameters that describe the nature of the incident and its potential impact on risk:

- Consequence severity (no. of people affected & vulnerability, environmental impact, financial loss;
- Personnel exposure;
- Alternatives to avoid danger;
- Demand rate.

The risk graphs presented in the Terms of Reference (Ref. 6) were agreed by KPC for the purposes of this SIL assessment. The grading has been carried out without taking credit for the IPF so that the criticality of the IPF can be established.

A pre-requisite to the SIL assessment in IEC 61511 is that all the required IPFs have been identified by a preceding hazard and risk analysis. For the Qasr Compression project, this has been achieved by a combination of past experience of designing such systems (as allowed by Ref. 5, Section 8.2.1), and the preceding HAZOP (Ref. 2).

2.2.2 Key Criteria

Any IPF requiring SIL 4 shall not be accepted, and additional protective measures shall be provided.

Any SIL required at level 2 or higher shall be confirmed during detailed design using a more detailed quantitative approach, e.g. Fault Tree Analysis, since the risk graph method is necessarily coarse in nature.

2.2.3 Detailed Steps

The assessment process involves several repetitive steps for each of the IPF loops. These are identified in Table 2-2:

Table 2-2 SIL Assessment - Steps for Review of each IPF

1.	Identify loop (record tag and P&ID No.)
2.	Determine functionality of loop and potential hazard(s) being protected against
3.	Identify causes for demand.
4.	Evaluate potential consequences (without risk reduction measures)
5.	Determine Safety IL with Risk Graph (Figure 4-1) using the following parameters: • Consequence Severity (no of people exposed + vulnerability) • Personnel Exposure (fraction of time exposed) • Alternatives to avoid danger • Demand rate
6.	Determine IL for environmental loss based on E.
7.	Determine IL for financial loss based on F
8.	Required IL to be the highest of the three (S, E, F)
9.	Adjust IL if same risk is limited by other independent measures • Take the value of SIL derived in steps 1-8 • Identify independent risk reduction measures & adjust IL (PSV up to 2, F&G gas detection for safety=1, etc.)
10.	Record the results and any associated assumptions or actions.
11.	Repeat steps 1 to 10 for each of the IPF loops.

3 STUDY BASIS

The master documents used as a starting point were the P&IDs and ESD Cause and Effects matrices. These are listed in Table 3-1 and Table 3-2, and are included in Appendices B and C.

Any changes to the basis will require their impact to be re-assessed, and the degree of further assessment established.

3.1 Documents Supplied

Documents used as a starting point are listed in Table 3-1 and Table 3-2, as per the Terms of Reference (Ref. 6).

Table 3-1 P&IDs

Drawing Number	Title
J08509A-P-DW-12210	Gas manifolds
J08509A-P-DW-12211	Compressor Suction Drum Train A
J08509A-P-DW-12212	Compressor Train A
J08509A-P-DW-12213	Compressor Discharge Cooler Train A
J08509A-P-DW-12214	Compressor Discharge Drum Train A
J08509A-P-DW-12215	Condensate manifolds
J08509A-P-DW-12221	Compressor Suction Drum Train B
J08509A-P-DW-12222	Compressor Train B
J08509A-P-DW-12223	Compressor Discharge Cooler Train B
J08509A-P-DW-12224	Compressor Discharge Drum Train B
J08509A-P-DW-12250	Condensate Suction Drum A
J08509A-P-DW-12251	Condensate Export Pumps A, B & C
J08509A-P-DW-12254	Condensate Suction Drum B
J08509A-P-DW-12261 **	Flash Gas Compressor A (Future)
J08509A-P-DW-12262 **	Flash Gas Compressor B (Future)
J08509A-P-DW-12300 **	Instrument Air Generation
J08509A-P-DW-12301 **	Inert Gas Generation
J08509A-P-DW-12302	HP Fuel Gas (Flash Gas) Feed
J08509A-P-DW-12303	HP Fuel Gas (Process Gas) Feed
J08509A-P-DW-12304	Start Up HP Fuel Gas
J08509A-P-DW-12305	HP Fuel Gas KO Drum
J08509A-P-DW-12306 **	Mercury Removal Unit (MRU)
J08509A-P-DW-12307	HP Fuel Gas System

Drawing Number	Title
J08509A-P-DW-12308	LP Fuel Gas System
J08509A-P-DW-12309	HP Flare Collection
J08509A-P-DW-12310	LP Sources to Cold Vent Collection
J08509A-P-DW-12311	Closed Drains
J08509A-P-DW-12314	Closed Drain Transfer Pumps A & B
J08509A-P-DW-12315	Instrument Air Receiver and Distribution
J08509A-P-DW-12316 **	Inert Gas Distribution, Compression and Receiver
J08509A-P-DW-12353	Process Tie-In New Gas and Condensate Systems
J08509A-P-DW-12354	Process Tie-In Black-start Fuel Gas System
J08509A-P-DW-12355	Process Tie-In Fuel Gas to Phase I & Phase II Consumers
J08509A-P-DW-12356	Process Tie-In HP Flare
J08509A-P-DW-12357	Process Tie-In Cold Vent System
J08509A-P-DW-12358	Process Tie-In Methanol
J08509A-P-DW-12359	Process Tie-In Train II Separator QA-V-3002A Inlet Throttle Valve
J08509A-P-DW-12360	Process Tie-In Train II Separator QA-V-3002B Inlet Throttle Valve
J08509A-P-DW-12361	Process Tie-In Train II Separator QA-V-3002C Inlet Throttle Valve
J08509A-P-DW-12362	Process Tie-In Train II Separator QA-V-4002A Inlet Throttle Valve
J08509A-P-DW-12363	Process Tie-In Train II Separator QA-V-4002B Inlet Throttle Valve
J08509A-P-DW-12364	Process Tie-In Instrument Air Phase I
J08509A-P-DW-12365	Process Tie-In Instrument Air Phase II
J08509A-P-DW-12366	Process Tie-In Produced Water Phase II
J08509A-P-DW-12367	Process Tie-In Produced Water Phase I
J08509A-P-DW-12368	Process Tie-In SHAMS Start-Up Fuel Gas

** Drawing was not assessed

Table 3-2 Cause & Effects Diagrams

Drawing Number	Title
J08509A P-DW-12400	ESD Cause & Effects

3.2 Study Breakdown

The 54 IPFs identified and reviewed in the study are listed in Table 3-3.

Table 3-3: Study Breakdown - IPFs Examined

W/S No	Inst. Tag	System	Role of IPF	P&ID
1	80-LIT-101 LL	Process Gas Compression	To protect the condensate suction drum from overpressure from compressor suction drum and avoid PSV lifting.	12211
2	80-LIT-101 HH	Process Gas Compression	Prevent liquid carry-over from compressor suction drum into gas compressor.	12211
3	80-PIT-110 LL	Process Gas Compression	To protect the compressor from low suction pressure and prevent flow to export manifold	12212
4	80-PIT-111 HH	Process Gas Compression	To trip the compressor and discharge cooler on high discharge pressure and prevent flow to export manifold	12212
5	80-TIT-102 HH	Process Gas Compression	To trip the compressor and discharge cooler on high discharge temperature and prevent flow to export manifold	12212
6	80-VIT-101 HH	Process Gas Compression	To trip the compressor and discharge cooler at high compressor vibration and prevent flow to export manifold	12212
7	80-TIT-110 HH	Process Gas Compression	To trip the compressor and discharge cooler at high compressor bearing temperature and prevent flow to export manifold	12212
8	80-TIT-108 LL	Process Gas Compression	To trip compressor discharge cooler fan at low discharge temperature. To autoset the cooler fan following increase in temperature above set point.	12213
9	80-TIT-108 HH	Process Gas Compression	To trip compressor and discharge cooler at high discharge temperature and prevent flow to export manifold	12213
10	80-LIT-104 LL	Process Gas Compression	To protect the condensate separator from overpressure from compressor discharge drum and avoid PSV lifting.	12214
11	80-LIT-104 HH	Process Gas Compression	Prevent liquid carry over into the second stage compression system and gas export manifold	12214
12	80-LIT-002A LL	Condensate Drums and Pumps	To prevent export pump damage.	12250
13	80-LIT-002A HH	Condensate Drums and Pumps	Prevent condensate carryover into the fuel gas system and flash gas compressor (future).	12250
14	80-PT-002A HH	Condensate Drums and Pumps	To prevent overpressure of the condensate suction drums.	12250

W/S No	Inst. Tag	System	Role of IPF	P&ID
15	80-LIT-021A LL	Condensate Drums and Pumps	To prevent condensate export to the produced water treatment package and ultimately gas blow-by.	12250
16	80-PI-XXX HH A/B/C	Condensate Drums and Pumps	To protect the discharge piping of the condensate transfer pump against over pressure.	12250
17	80-PIT-010A LL, 80-PIT-010B LL, 80-PIT-010C LL	Condensate Drums and Pumps	Protect the pumps against low suction pressure. ***Note: These were changed by the HAZOP to high vibration or low flow trips - A high vibration alarm and a high-high vibration trip will be provided for each of the pumps.***	12251
18	80-LIT-002B HH	Condensate Drums and Pumps	Prevent further condensate flow to the condensate suction drum and condensate carry over into the fuel gas system.	12254
19	80-PT-002B HH	Condensate Drums and Pumps	To prevent overpressure of the condensate separator	12254
20	80-LIT-021B LL	Condensate Drums and Pumps	To prevent condensate export to the produced water treatment package and ultimately gas blow-by	12254
21	80-PI-070A LL	Flash Gas Compression	To protect the flash gas compressor from low suction pressure.	12261
22	80-PIT-021A HH	Flash Gas Compression	To trip the flash compressor and protect the discharge piping from over pressure	12261
23	80-TIT-004A HH	Flash Gas Compression	To trip the compressor and to protect discharge piping from high temperature.	12261
24	80-VIT-001A-HH	Flash Gas Compression	To trip the compressor at high compressor vibration and prevent damage to the compressor	12261
25	80-TIT-002A HH	Flash Gas Compression	To trip the compressor at high compressor bearing temperature and prevent damage to the compressor.	12261
26	80-PIT-070B LL	Flash Gas Compression	To protect the flash gas compressor from low suction pressure.	12262
27	80-PIT-021B HH	Flash Gas Compression	To trip the flash compressor and protect the discharge piping from over pressure	12262
28	80-TIT-004B HH	Flash Gas Compression	To trip the compressor and to protect discharge piping from high temperature.	12262
29	80-VIT-001B HH	Flash Gas Compression	To trip the compressor at high compressor vibration and prevent damage to the compressor	12262
30	80-TIT-002B HH	Flash Gas Compression	To trip the compressor at high compressor bearing temperature and prevent damage to the compressor.	12262

W/S No	Inst. Tag	System	Role of IPF	P&ID
31	80-PIT-062 HH	Flash Gas Compression	To protect the flash gas compression system from potential over pressurisation due to reverse flow from process gas compressors suction.	12262
32	80-PIT-075 LL 1	Air and Nitrogen Systems	To isolate the plant air supply in order to maintain the instrument air supply as long as possible	12300
33	80-PIT-075 LL 2	Air and Nitrogen Systems	To isolate the nitrogen generator air supply in order to maintain the instrument air supply as long as possible	12300
34	50-PIT-079 A/B/C LL	Air and Nitrogen Systems	To allow controlled shut down of the plant whilst there is still sufficient inventory of instrument air to allow this to occur.	12315
35	80-PIT-085 LL	Air and Nitrogen Systems	To isolate non-essential users to protect supply to essential users (compressors)	12316
36	80-LIT-005 LL	Fuel Gas System	Prevent gas blow by from HP Fuel Gas KO drum to the closed drains drum.	12305
37	80-LIT-005 HH	Fuel Gas System	To prevent liquid carry over into the Mercury Removal Unit and downstream equipment.	12305
38	80-PIT-004 HH	Fuel Gas System	To prevent overpressure of HP fuel gas system	12305
39	80-PIT-004 LL	Fuel Gas System	To trip the compressors and power generators at low fuel gas pressure.	12305
40	80-TIT-007 HH	Fuel Gas System	Prevent over heating of flash gas to HP fuel gas feed.	12302
41	80-TIT-005 HH	Fuel Gas System	To protect the heater elements from over heating.	12302
42	80-FI-XXX LL	Fuel Gas System	Prevent over heating of flash gas to HP fuel gas feed.	12302
43	80-TIT-011 HH	Fuel Gas System	To protect the piping downstream of the HP fuel gas preheater and the HP fuel gas KO drum from over heating	12303
44	80-TIT-009 HH	Fuel Gas System	To protect the heater elements from over heating.	12303
45	80-TIT-022A HH, 08-TIT-022B HH	Fuel Gas System	To trip the HP fuel gas heater and protect the HP and LP fuel gas systems from excessively high temperatures	12307
46	80-TIT-019A HH 80-TIT-019B HH	Fuel Gas System	To cut the power supply in the event of thermal overload to the heater.	12307
47	80-TDI-XXX LL	Fuel Gas System	To protect the gas turbines from non superheated gas	12302
48	80-LIT-008 LL	Fuel Gas System	Prevent gas blow by from LP Fuel Gas KO drum to the closed drains drum	12308

W/S No	Inst. Tag	System	Role of IPF	P&ID
49	80-PIT-053 LL	Fuel Gas System	To open the back-up fuel gas supply to essential users (flare pilots and purges) if the LP fuel gas supply is lost in case ESD (1&2) activation.	12308
50	80-PIT-053 HH	Fuel Gas System	To protect the LP fuel gas knock out drum.	12308
51	80-LIT-008 HH	Fuel Gas System	To prevent liquid carry into the LP fuel gas distribution system.	12308
52	65-LIT-002 LL	Closed Drain System	Protect closed drains drum pump	12250
53	65-LIT-002 HH	Closed Drain System	To prevent the closed drains drum overflowing into the cold vent and not to allow the plant to operate when the closed drain drum is full	12250
54	30-LIT-344 HH	Flare	To shut the plant down if the is high level in the flare KO drum.	12356

3.3 Assumptions & Assurances

It will be necessary to verify the validity of the recorded assumptions to ensure that the study findings remain valid; this will be tracked in full by the Safety Action Management System (SAMS). Any changes to the assumptions will need to be reviewed by KPC to assess their significance and the requirement for any follow-up reviews.

The assumptions made in this review are based on some specific aspects of the current design of the new facilities. The hierarchy of the ESD system is relevant in terms of assessing the financial consequences of lost production. The hierarchy is as follows:

Level 1 Emergency Shutdown:

Full plant shutdown of process and utility units.
Automatic depressuring.

Level 2 Emergency Shutdown:

Full plant shutdown of process and utility units.
No automatic depressuring.

Clearly recovery after a Level 2 ESD will be quicker than after a Level 1 ESD as the facilities are not depressured.

Table 3-4: List of Assumptions

W/S No.	Assumption	Verification by
1	The cost of 1 day of lost production is approximately US$ 2.6 million (MM), 1 12-hour shift of lost production is also more than US$ 1 million (MM), a brief interruption of a few hours, is <MM, but any extended shutdown is greater than US$ 10 million (>MM).	KPC
2	During parallel operation of compressors, loss of 1 compressor will not cause loss of production as there is a spare compressor. **BUT** during series operation of compressors, loss of any single compressor will halve the production rate (<MM for 1 shift, MM for more than 1 shift)	KPC
3	The cost of replacing an export pipeline (e.g. as the result of corrosion) is >M	KPC
4	An event that damages both condensate export pumps will reduce production by 50% as there is only one 50% spare	GOGC
5	Interruption of the HP fuel gas supply will trip the compressors and require 1 shift to recover. Loss of containment as a result of the failure will lead to an extended shutdown (>MM)	GOGC
6	A Level 2 ESD will require at least 1 shift to recover (MM)	GOGC
7	The difference between a controlled Level 2 ESD on loss of instrument air, and an uncontrolled shutdown is an increase of material lost to flare because BDVs may open before isolatable sections are shut-in.	GOGC
8	Loss of the nitrogen supply (after the buffer vessel capacity is exhausted) will lead to damage to the compressor seals, and loss of containment.	GOGC
9	Liquid carryover into the LP fuel gas system will extinguish the pilots requiring at least 1 shift to recover	GOGC
10	Liquid carryover into the MRU will cause some ongoing loss of production to bypass the MRU and clean filters, as well as the cost of replacement of adsorbent (MM)	GOGC
11	Liquid carryover into the cold vent system will require 1 shift to clear	GOGC
12	Liquid carryover from the flare drum may lead to loss of containment within the process area requiring extended downtime to recover.	GOGC
13	The Closed Drains drum will only be used intermittently, most frequently during preparation for a plant shutdown	GOGC
14	High level protection for the Closed Drains Drum will not isolate the majority of operations that transfer liquid into the Closed Drains Drum, since they are manually controlled.	GOGC
15	Each compressor will have a CCC control system, or its equivalent, which is highly reliable.	GOGC
16	The Closed drains Drum is vented to the Cold Vent via a 6” line, which is sufficient to prevent overpressure from all reasonably foreseeable events, including gas blow-by.	GOGC

4 MAIN FINDINGS

4.1 Overview of Findings

A total of 54 IPFs were reviewed during the SIL assessment. The results are summarised in Table 4-1.

Table 4-1: Summary of SIL Classifications

Classification	No. of IPFs	Comments
SIL 4	0	None
SIL 3	0	None
SIL 2	13	The majority are financial, arising from failure of one or more compressors, or the HP fuel gas supply on which they depend.
SIL 1	19	The majority of these are also financial.
SIL 0 (or unclassified)	22	These are IPFs which are conventionally expected in a HAZOP, but which do not provide a substantial reduction in risk.
Requiring further assessment	0	None identified
Total IPFs Reviewed	54	

A listing of IPFs in each classification, along with the consequence category driving the overall classification (S, E, F), is given in Table 4-2 to Table 4-5. The SIL classifications represent the target integrity required for the respective IPFs. These targets will need to be demonstrated as the systems are designed in future stages of the project.

There were no IPFs that could not be classified at the FEED stage due to insufficient information.

4.2 IPFs Classified SIL 2

Table 4-2 contains the list of the 13 IPFs categorised SIL 2.

Table 4-2: IPFs with Classification SIL 2

W/S No	Inst. Tag	System	Role of IPF	Driving Risk		
				S	F	E
2	80-LIT-101 HH	Process Gas Compression	Prevent liquid carry-over from compressor suction drum into gas compressor.		✔	
5	80-TIT-102 HH	Process Gas Compression	To trip the compressor and discharge cooler on high discharge temperature and prevent flow to export manifold		✔	
6	80-VIT-101 HH	Process Gas Compression	To trip the compressor and discharge cooler at high compressor vibration and prevent flow to export manifold		✔	
7	80-TIT-110 HH	Process Gas Compression	To trip the compressor and discharge cooler at high compressor bearing temperature and prevent flow to export manifold		✔	

W/S No	Inst. Tag	System	Role of IPF	Driving Risk		
				S	F	E
9	80-TIT-108 HH	Process Gas Compression	To trip the compressor and discharge cooler at high compressor vibration and prevent flow to export manifold		✔	
11	80-LIT-104 HH	Process Gas Compression	Prevent liquid carry over into the second stage compression system and gas export manifold		✔	
31	80-PIT-062 HH	Flash Gas Compression	To protect the flash gas compression system from potential over pressurisation due to reverse flow from process gas compressors suction.	✔		
43	80-TIT-011 HH	Fuel Gas System	To protect the piping downstream of the HP fuel gas preheater and the HP fuel gas KO drum from over heating	✔	✔	
44	80-TIT-009 HH	Fuel Gas System	To protect the heater elements from over heating.	✔	✔	
45	80-TIT-022A HH 80-TIT-022B HH	Fuel Gas System	To trip the HP fuel gas heater and protect the HP and LP fuel gas systems from excessively high temperatures	✔	✔	
46	80-TIT-019A HH, 80-TIT-019B HH	Fuel Gas System	To cut the power supply in the event of thermal overload to the heater.		✔	
47	80-TDI-XXX LL	Fuel Gas System	To protect the gas turbines from non superheated gas		✔	
54	30-LIT-344 HH	Flare	To shut the plant down if the is high level in the flare KO drum.	✔	✔	

4.3 IPFs Classified SIL 1

Table 4-3 contains a list of the 19 IPFs categorised as SIL 1.

Table 4-3: IPFs with Classification SIL 1

W/S No	Inst. Tag	System	Role of IPF	Driving Risk		
				S	F	E
1	80-LIT-101 LL	Process Gas Compression	To protect the condensate suction drum from overpressure from compressor suction drum and avoid PSV lifting.	✔		
3	80-PIT-110 LL	Process Gas Compression	To protect the compressor from low suction pressure and prevent flow to export manifold		✔	
4	80-PIT-111 HH	Process Gas Compression	To trip the compressor and discharge cooler on high discharge pressure and prevent flow to export manifold	✔		
8	80-TIT-108 LL	Process Gas Compression	To trip compressor discharge cooler fan at low discharge temperature.		✔	
10	80-LIT-104 LL	Process Gas Compression	To protect the condensate separator from overpressure from compressor discharge drum and avoid PSV lifting.		✔	
12	80-LIT-002A LL	Condensate Drums and Pumps	To prevent export pump damage.		✔	

W/S No	Inst. Tag	System	Role of IPF	Driving Risk		
				S	F	E
13	80-LIT-002A HH	Condensate Drums and Pumps	Prevent condensate carryover into the fuel gas system and flash gas compressor (future).		✔	
14	80-PT-002A HH	Condensate Drums and Pumps	To prevent overpressure of the condensate suction drums.	✔		
16	80-PI-XXX HH A/B/C	Condensate Drums and Pumps	To protect the discharge piping of the condensate transfer pump against over pressure.	✔		
18	80-LIT-002B HH	Condensate Drums and Pumps	Prevent condensate carryover into the fuel gas system and flash gas compressor (future).		✔	
19	80-PT-002B HH	Condensate Drums and Pumps	To prevent overpressure of the condensate separator	✔		
32	80-PIT-075 LL 1	Air and Nitrogen Systems	To isolate the plant air supply in order to maintain the instrument air supply as long as possible		✔	
33	80-PIT-075 LL 2	Air and Nitrogen Systems	To isolate the nitrogen generator air supply in order to maintain the instrument air supply as long as possible		✔	
35	80-PIT-085 LL	Air and Nitrogen Systems	To isolate non-essential users to protect supply to essential users (compressors)		✔	
37	80-LIT-005 HH	Fuel Gas System	To prevent liquid carry over into the Mercury Removal Unit and downstream equipment.		✔	
38	80-PIT-004 HH	Fuel Gas System	To prevent overpressure of HP fuel gas system		✔	
41	80-TIT-005 HH	Fuel Gas System	To protect the heater elements from over-heating.		✔	
51	80-LIT-008 HH	Fuel Gas System	To prevent liquid carry into the LP fuel gas distribution system.		✔	
53	65-LIT-002 HH	Closed Drain System	To prevent the closed drains drum overflowing into the cold vent and not to allow the plant to operate when the closed drain drum is full		✔	

4.4 IPFs Classified SIL 0

Table 4-4contains a list of the 22 IPFs categorised as SIL 0.

Table 4-4: IPFs with Classification SIL 0

W/S No	Inst. Tag	System	Role of IPF	Driving Risk		
				S	F	E
15	80-LIT-021A LL	Condensate Drums and Pumps	To prevent condensate export to the produced water treatment package and ultimately gas blow-by.	-	-	-
17	80-PIT-010A LL, 80-PIT-010B LL, 80-PIT-010C LL	Condensate Drums and Pumps	Protect the pumps against low suction pressure. ***Note: These were changed by the HAZOP to high vibration or low flow trips - A high vibration alarm and a high-high vibration trip will be provided for each of the pumps.***	-	-	-
20	80-LIT-021B LL	Condensate Drums and Pumps	To prevent condensate export to the produced water treatment package and ultimately gas blow-by	-	-	-
21	80-PI-070A LL	Flash Gas Compression	To protect the flash gas compressor from low suction pressure.	-	-	-
22	80-PIT-021A HH	Flash Gas Compression	To trip the flash compressor and protect the discharge piping from over pressure	-	-	-
23	80-TIT-004A HH	Flash Gas Compression	To trip the compressor and to protect discharge piping from high temperature.	-	-	-
24	80-VIT-001A-HH	Flash Gas Compression	To trip the compressor at high compressor vibration and prevent damage to the compressor	-	-	-
25	80-TIT-002A HH	Flash Gas Compression	To trip the compressor at high compressor bearing temperature and prevent damage to the compressor.	-	-	-
26	80-PIT-070B LL	Flash Gas Compression	To protect the flash gas compressor from low suction pressure.	-	-	-
27	80-PIT-021B HH	Flash Gas Compression	To trip the flash compressor and protect the discharge piping from over pressure	-	-	-
28	80-TIT-004B HH	Flash Gas Compression	To trip the compressor and to protect discharge piping from high temperature.	-	-	-
29	80-VIT-001B HH	Flash Gas Compression	To trip the compressor at high compressor vibration and prevent damage to the compressor	-	-	-
30	80-TIT-002B HH	Flash Gas Compression	To trip the compressor at high compressor bearing temperature and prevent damage to the compressor.	-	-	-
34	50-PIT-079 A/B/C LL	Air and Nitrogen Systems	To allow controlled shut down of the plant whilst there is still sufficient inventory of instrument air to allow this to occur.	-	-	-
36	80-LIT-005 LL	Fuel Gas System	Prevent gas blow by from HP Fuel Gas KO drum to the closed drains drum.	-	-	-
39	80-PIT-004 LL	Fuel Gas System	To trip the compressors and power generators at low fuel gas pressure.	-	-	-
40	80-TIT-007 HH	Fuel Gas System	Prevent over heating of flash gas to HP fuel gas feed.	-	-	-
42	80-FI-XXX LL	Fuel Gas System	Prevent over heating of flash gas to HP fuel gas feed.	-	-	-
48	80-LIT-008 LL	Fuel Gas System	Prevent gas blow by from LP Fuel Gas KO drum to the closed drains drum	-	-	-
49	80-PIT-053 LL	Fuel Gas System	To open the back-up fuel gas supply to essential users (flare pilots and purges) if the LP fuel gas supply is lost.	-	-	-

W/S No	Inst. Tag	System	Role of IPF	Driving Risk		
				S	F	E
50	80-PIT-053 HH	Fuel Gas System	To protect the LP fuel gas knock out drum.	-	-	-
52	65-LIT-002 LL	Closed Drain System	Protect closed drains drum pump	-	-	-

4.1 IPFs by Dominant Aspect

The distribution of IPFs by dominant factor is as follows:

Safety	6
Financial	23
Environmental	0
More than 1 factor	3
SIL 0 for all 3 factors	22

It is noteworthy that the predominant factor is financial risk due to loss of production.

4.2 Recommendations

One recommendation was made during the SIL assessment, to consider providing separate initiators on duties where the same instrument provides input into two distinct outputs under two distinct initiating conditions. This is important where there may be an interaction between two events. For example, if failure of the low low level switch on a vessel closes such as the compressor suction drum the liquid outlet route the liquid level will rise and may eventually carry over into the compressor as the high high level switch will also have failed.

4.3 Safety Action Management System (SAMS)

All the key study assumptions, actions and recommendations will be captured and tracked in the GOGC SAMS register in accordance with the GOGC procedure (CON-PR-460, Ref. 7).

This register will list all actions arising from the HAZID / HAZOP / SIL workshops in a simple spreadsheet format for action and information. It will also include all recommendations for further work contained in any formal safety studies and any HS&E concerns formally raised by discipline engineers. The register will indicate the status of all actions at the end of FEED and where these actions have been addressed in the project documentation.

5 REFERENCES

1. J08509A-F-HA-20036, HAZID Study Report
2. J08509A-F-HA-20040, HAZOP Study Report
3. BS IEC 61511-1, Functional Safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definition, system, hardware and software requirements
4. BS IEC 61511-2, Functional Safety – Safety instrumented systems for the process industry sector – Part 2: Guidelines for the application of BS IEC 61511-1
5. BS IEC 61511-3, Functional Safety – Safety instrumented systems for the process industry sector – Part 3: Guidelines for the determination of the required safety integrity levels
6. J08509A-F-HA-20056, SIL Terms of Reference
7. CON-PR-460, 'SAMS (Safety Action Management System)'

APPENDIX A – SIL WORKSHEETS

	Qasr SIL Assessment Worksheet Number:		1

Trip:	80-LIT-101 LL
System No. / Name:	Process Gas Compression
P&ID No:	12211
Role of protection function:	To protect the condensate suction drum from overpressure from compressor suction drum and avoid PSV lifting.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Failure of 80-LIC-102	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Over pressurise both condensate suction drum, which could lead to loss of containment. Potential for fire and explosion causing multiple deaths. Reportable release. Los of several months production.
Functional requirements necessary to prevent hazard:	Close ESDV-103. Isolate the condensate outlet from QA-V-8001A
Process condition detected by 80-LIT-101 LL	80-LIT-101 LL
Final actuation device(s) necessary to prevent hazard:	ESDV-103
Functional requirements for orderly shutdown and start-up:	Auto reset of ESDV-103, when level is restored.

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	MD	>M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	3	**2**	**0**
Other Protection Systems:	PI- 002A/B HH, PSV-007 A/B		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**1**	**0**	**0**
Overall Integrity Required:	**1**		

Consequences of Spurious Trip	Level will rise in the compressor suction drum. If thecompressor trips there is a short term loss of production but if liquid carries over ir

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		2

Trip:	80-LIT-101 HH
System No. / Name:	Process Gas Compression
P&ID No:	12211
Role of protection function:	Prevent liquid carry-over from compressor suction drum into gas compressor.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Failure of 80-LIC-102.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Liquid carry over into compressor causing mechanical damage, taking several weeks to repair. Potential loss of containment from compressor seals. Slight injury, no significant enviromental damage (RR). In early production there is a spare compressor available. In later production with series operation of the compressors, failure will lead to loss of production but at a lower producing rate.
Functional requirements necessary to prevent hazard:	Trip compressor and shut in the compression train.
Process condition detected by 80-LIT-101 HH	80-LIT-101 HH
Final actuation device(s) necessary to prevent hazard:	Compressor trip system.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	>M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**0**
Other Protection Systems:	None Specified		
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**0**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Short term loss of production.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		3

Trip:	80-PIT-110 LL
System No. / Name:	Process Gas Compression
P&ID No:	12212
Role of protection function:	To protect the compressor from low suction pressure and prevent flow to export manifold

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	ESDV-101A/B fail closed	L	Low 3 - 30 yrs
2	PV-XXX (throttle valve) fail closed	L	Low 3 - 30 yrs
3	Compressor control system fail	L	Low 3 - 30 yrs
4			
5			

Consequence: With no protection.	Surge of compressor, potential mechanical damage. Compressor out of service for several weeks. No injury to personnel or damage to the enviroment.In early production there is a spare compressor available. In later production with series operation of the compressors, failure will lead to loss of production but at a lower producing rate.
Functional requirements necessary to prevent hazard:	Anti surge control.
Process condition detected by 80-PIT-110 LL	80-PI-110 LL, 80-PI-109 L
Final actuation device(s) necessary to prevent hazard:	Compressor trip system.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		>M	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	SIL	AIL	EIL
	0	2	0
Other Protection Systems:	Compressor condition monitoring, vibration etc.		
Integrity reduction (other protection)	1	1	1
Integrity reduction (assumptions)			
Revised integrity required	0	1	0
Overall Integrity Required:	1		
Consequences of Spurious Trip	Short term loss of production.		

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		4

Trip:	80-PIT-111 HH		
System No. / Name:	Process Gas Compression		
P&ID No:	12212		
Role of protection function:	To trip the compressor and discharge cooler on high discharge pressure and prevent flow to export manifold		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	ESDV-102A/B fail closed.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Over-rating of the compressor and potential mechanical damage. Several weeks downtime to repair damage. Loss of containment leading to fire and explosion, multiple deaths, reportable damage to the enviroment.In early production there is a spare compressor available. In later production with series operation of the compressors, failure will lead to loss of production but at a lower producing rate.
Functional requirements necessary to prevent hazard:	Anti-surge control.
Process condition detected by 80-PIT-111 HH	80-PIT-111 HH, 80-PIT-112 H
Final actuation device(s) necessary to prevent hazard:	Compressor trip system.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	MD	>M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	3	**2**	**0**
Other Protection Systems:	Full flow relief valve on compressor discharge.		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**1**	**0**	**0**
Overall Integrity Required:	**1**		
Consequences of Spurious Trip			

Assumptions:	
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Recommendations	
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GENESIS	Qasr SIL Assessment Worksheet Number:		5

Trip:	80-TIT-102 HH		
System No. / Name:	Process Gas Compression		
P&ID No:	12212		
Role of protection function:	To trip the compressor and discharge cooler on high discharge temperature and prevent flow to export manifold		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of an unstream cooler.	L	Low 3 - 30 yrs
2	Low compressor suction pressure.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Exceed the design temperature of the discharge system including the after-cooler. Potential mechanical damage to the compressor, several weeks down-time to repair. Damage to the after-cooler. Loss of containment, potential to injure personnel and reportable damage to the enviroment..In early production there is a spare compressor available. In later production with series operation of the compressors, failure will lead to loss of production but at a lower producing rate.
Functional requirements necessary to prevent hazard:	Trip the compressor.
Process condition detected by 80-TIT-102 HH	80-TIT-102 HH, 80-TIT-101 H, 80-TIT-103 H
Final actuation device(s) necessary to prevent hazard:	Compressor trip system.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	>M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	P		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**0**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Short term loss of production

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		6

Trip:	80-VIT-101 HH		
System No. / Name:	Process Gas Compression		
P&ID No:	12212		
Role of protection function:	To trip the compressor and discharge cooler at high compressor vibration and prevent flow to export manifold		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Compressor running out of balance, due to bearing failure, liquid carry-over or other similar causes.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the compressor and loss of containment. Potential mechanical damage to the compressor, several weeks down-time to repair. Damage to the after-cooler. Loss of containment, potential to injure personnel and reportable damage to the enviroment.In early production there is a spare compressor available. In later production with series operation of the compressors, failure will lead to loss of production but at a lower producing rate.
Functional requirements necessary to prevent hazard:	Trip compressor
Process condition detected by 80-VIT-101 HH	80-VIT-101 HH (a pre-alarm is required)
Final actuation device(s) necessary to prevent hazard:	Compressor tripsystem.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	>M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	P		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**0**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Short term loss of production

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		7

Trip:	80-TIT-110 HH
System No. / Name:	Process Gas Compression
P&ID No:	12212
Role of protection function:	To trip the compressor and discharge cooler at high compressor bearing temperature and prevent flow to export manifold

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Failure of the bearing	L	Low 3 - 30 yrs
2	Failure of the lubrication system.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Potential mechanical damage to the compressor, several weeks down-time to repair. Damage to the after-cooler. Loss of containment, potential to injure personnel and reportable damage to the enviroment. In early production there is a spare compressor available. In later production with series operation of the compressors, failure will lead to loss of production but at a lower producing rate.
Functional requirements necessary to prevent hazard:	Compressor trip
Process condition detected by 80-TIT-110 HH	80-TIT-110 HH (requires pre-alarm)
Final actuation device(s) necessary to prevent hazard:	Compressor trip system
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	>M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**0**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Short term loss of production

Assumptions:

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Recommendations

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GENESIS	Qasr SIL Assessment Worksheet Number:		8

Trip:	80-TIT-108 LL		
System No. / Name:	Process Gas Compression		
P&ID No:	12213		
Role of protection function:	To trip compressor discharge cooler fan at low discharge temperature.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Fan fails to stop on air fin cooler.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Increase condensation and potential for hydrate formation. Potential production limitation in end of line facility.Potential requirement to shut down the compressor to clear the hydrate choke. No risk to personnel or the enviroment. In early production there is a spare compressor available. In later production with series operation of the compressors, failure will lead to loss of production but at a lower producing rate.
Functional requirements necessary to prevent hazard:	Trip the fans on the air cooler.
Process condition detected by 80-TIT-108 LL	80-TIT-108 LL, 80-TIC-107 L
Final actuation device(s) necessary to prevent hazard:	Fan trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	High export gas temperature and increased corrosion in the export pipelines

	Assumptions:
1	
2	
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		9

Trip:	80-TIT-108 HH		
System No. / Name:	Process Gas Compression		
P&ID No:	12213		
Role of protection function:	To trip compressor and discharge cooler at high discharge temperature and prevent flow to export manifold		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Loss of fans on the air fin cooler	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Hot gas exported into the pipelines, leading to increased corrosion and potential to exceed the design temperature of the export pipelines. Hot condensate reutrn to phase 1 and 2 separators. Cumulative damage to the export pipelines with possible requirement for early replacement, and reduced production during replacement period. Enviromental damage caused by leakage from pipeline.
Functional requirements necessary to prevent hazard:	Trip the compressor
Process condition detected by 80-TIT-108 HH	80-TIT-108 HH, 80-TIC-107 H
Final actuation device(s) necessary to prevent hazard:	Compressor trip system
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		>M	MT
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**1**
Other Protection Systems:	Corrosion inhibitor		
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**1**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Short term loss of production

	Assumptions:
1	
2	
3	
4	

	Recommendations
1	
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3	
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	Qasr SIL Assessment Worksheet Number:		10

Trip:	80-LIT-104 LL		
System No. / Name:	Process Gas Compression		
P&ID No:	12214		
Role of protection function:	To protect the condensate separator from overpressure from compressor discharge drum and avoid PSV lifting.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of level control	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Gas blow by to phases 1 & 2 separators leading to inefficient operation (design pressure of upstream and downstream equipment is the same).
Functional requirements necessary to prevent hazard:	Isolated the liquid outlet from the discharge drum.
Process condition detected by 80-LIT-104 LL	80-LIT-104 LL, 80-LIC-105 L
Final actuation device(s) necessary to prevent hazard:	ESDV-104
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Carry over see LIT-104 HH
Assumptions:	
1	
2	
3	
4	
Recommendations	
1	
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3	
4	

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	Qasr SIL Assessment Worksheet Number:		11

Trip:	80-LIT-104 HH		
System No. / Name:	Process Gas Compression		
P&ID No:	12214		
Role of protection function:	Prevent liquid carry over into the second stage compression system and gas export manifold		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of level control	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Carry-over is mainly water which will increase the corrosion rate in the pipeline. Cumulative damage to the export pipelines with possible requirement for early replacement, and reduced production during replacement period. Enviromental damage caused by leakage from pipeline.
Functional requirements necessary to prevent hazard:	Trip the compressor
Process condition detected by 80-LIT-104 HH	80-LIT-104 HH, 80-LIC-105 H
Final actuation device(s) necessary to prevent hazard:	Compressor trip system
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		>M	MT
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**1**
Other Protection Systems:	Corrosion inhibitor		
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**1**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Short term loss of production

Assumptions:	
1	
2	
3	
4	
Recommendations	
1	
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	Qasr SIL Assessment Worksheet Number:		12

Trip:	80-LIT-002A LL
System No. / Name:	Condensate Drums and Pumps
P&ID No:	12250
Role of protection function:	To prevent export pump damage.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Level control failure	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Damage the operating condensate export pumps (normally 2). Reduced production to 50% for one week. Potential for loss of containment through pump seals with minor injuries to personnel and damage to the enviroment.
Functional requirements necessary to prevent hazard:	Isolated the liquid outlet from the condensate suction drum and trip the pumps.
Process condition detected by 80-LIT-002A LL	80-LIT-002A LL, 80-LIC-001 L
Final actuation device(s) necessary to prevent hazard:	Pump trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	MM	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Short term loss of production

Assumptions:

1	
2	
3	
4	

Recommendations

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	Qasr SIL Assessment Worksheet Number:		13

Trip:	80-LIT-002A HH		
System No. / Name:	Condensate Drums and Pumps		
P&ID No:	12250		
Role of protection function:	Prevent further condensate flow to the condensate suction drum and condensate carry over into the fuel gas system.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Level control failure	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Liquid carry over into the HP fuel gas KO drum may cause the fuel gas system to trip requiring one shift to recover production. Liquid carry over into the flash gas compressor (future) will cause mechanical damage to the compressor and loss of flash gas to flare whilst the compressor is repaired.
Functional requirements necessary to prevent hazard:	Close all inlets to the condensate suction drum.
Process condition detected by 80-LIT-002A HH	80-LIT-002A HH, 80-LIC-001A H
Final actuation device(s) necessary to prevent hazard:	ESDV-011A, ESDV-104, 204, 304 & 404 close
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Loss of production for a shift.

Assumptions:

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2	
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Recommendations

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	Qasr SIL Assessment Worksheet Number:		14

Trip:	80-PT-002A HH		
System No. / Name:	Condensate Drums and Pumps		
P&ID No:	12250		
Role of protection function:	To prevent overpressure of the condensate suction drums.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Pressure control failure	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential to over pressure both the condesate suction drums causing loss of containment leading to fire explosion causing multiple deaths, damage to the enviroment and extended shut down.
Functional requirements necessary to prevent hazard:	Closed all the inlets to the condensate suction drum.
Process condition detected by 80-PT-002A HH	80-PT-002A HH, 80-PIC-003 H, 80-PI-002A H
Final actuation device(s) necessary to prevent hazard:	ESDV-011A, ESDV-104, 204, 304 & 404 close
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels			
	Safety	**Financial loss**	**Environmental Loss**
Consequences	MD	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	3	**2**	**1**
Other Protection Systems:	PSV-007A (to be uprated for full flow compressor suction drums) and PSV-006		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**1**	**0**	**0**
Overall Integrity Required:	**1**		
Consequences of Spurious Trip	Loss of production for a shift.		

	Assumptions:
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	Recommendations
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GENESIS	Qasr SIL Assessment Worksheet Number:		15

Trip:	80-LIT-021A LL		
System No. / Name:	Condensate Drums and Pumps		
P&ID No:	12250		
Role of protection function:	To prevent condensate export to the produced water treatment package		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of interface level control.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Condensate flowing into the degasser and from there into the API separator and potentially into the evaporation pond. Potential for flashed gas release into the degasser and major discharge of flammable gas from the cold vent. Potenial for injury for personnel if ignites, reportable enviromental release. Loss of a proportion of the produced condensate
Functional requirements necessary to prevent hazard:	Isolate the water outlet from the condensate suction drum.
Process condition detected by 80-LIT-021A LL	80-LIT-021A LL, 80-LIC-016A L
Final actuation device(s) necessary to prevent hazard:	ESDV-026A
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:	API separator downstream of the degassers will recover some of the condensate.		
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Water will carry over into the condensate and be exported into the pipelines, causing increased corrosion, see 80-LI-104 HH

Assumptions:	
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Recommendations	
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	Qasr SIL Assessment Worksheet Number:		16

Trip:	80-PI-XXX HH A/B/C
System No. / Name:	Condensate Drums and Pumps
P&ID No:	12250
Role of protection function:	To protect the discharge piping of the condensate transfer pump against over pressure.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Blocked outlet on the condensate export pump.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential to exceed the design pressure of the piping, loss of containment. Potential for fire explosion causing fatalities and significant damage to the enviroment. Potential for loss of production and cost of repair.
Functional requirements necessary to prevent hazard:	Trip the pump
Process condition detected by 80-PI-XXX HH A/B/C	80-PI-XXX HH A/B/C, 80-PI-012 A/B/C H
Final actuation device(s) necessary to prevent hazard:	Pump trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	MD	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	3	**2**	**1**
Other Protection Systems:	PSV-093 A/B/C sizzed for blocked discharge		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**1**	**0**	**0**
Overall Integrity Required:	**1**		
Consequences of Spurious Trip	No loss of production. Auto start the standby pump		

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		17

Trip:	80-PIT-010A LL, 80-PIT-010B LL, 80-PIT-010C LL (Changed by the HAZOP to high vibration or low flow trip)		
System No. / Name:	Condensate Drums and Pumps		
P&ID No:	12251		
Role of protection function:	Protect the pumps against low suction pressure		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Block inlet to the pumps	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the relevant condensate export pump. Loss of containment from the seal, minor enviromental impact. Potential for slight injury for personnel. No impact on production as there is a spare pump, cost of repair to the pump.
Functional requirements necessary to prevent hazard:	Trip the pump
Process condition detected by 80-PIT-010A LL, 80-PIT-010B LL, 80-PIT-010C LL	80-PIT-010A LL, 80-PIT-010B LL, 80-PIT-010C LL (Changed by the HAZOP to high vibration or low flow trip)
Final actuation device(s) necessary to prevent hazard:	Pump trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	No consequences. Stand by pump will auto start.		

	Assumptions:
1	
2	
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		18

Trip:	80-LIT-002B HH		
System No. / Name:	Condensate Drums and Pumps		
P&ID No:	12254		
Role of protection function:	Prevent further condensate flow to the condensate suction drum and condensate carry over into the fuel gas system.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Level control failure	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Liquid carry over into the HP fuel gas KO drum may cause the fuel gas system to trip requiring one shift to recover production. Liquid carry over into the flash gas compressor (future) will cause mechanical damage to the compressor and loss of flash gas to flare whilst the compressor is repaired.
Functional requirements necessary to prevent hazard:	Close all inlets to the condensate suction drum.
Process condition detected by 80-LIT-002B HH	80-LIT-002B HH, 80-LIC-001B H
Final actuation device(s) necessary to prevent hazard:	ESDV-011B, ESDV-104, 204, 304 & 404 close
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Loss of production for a shift.

Assumptions:	
1	
2	
3	
4	
Recommendations	
1	
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3	
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	Qasr SIL Assessment Worksheet Number:		19

Trip:	80-PT-002B HH		
System No. / Name:	Condensate Drums and Pumps		
P&ID No:	12254		
Role of protection function:	To prevent overpressure of the condensate separator		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Pressure control failure	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential to over pressure both the condesate suction drums causing loss of containment leading to fire explosion causing multiple deaths, damage to the enviroment and extended shut down.
Functional requirements necessary to prevent hazard:	Closed all the inlets to the condensate suction drum.
Process condition detected by 80-PT-002B HH	80-PT-002B HH, 80-PIC-003 H, 80-PI-002B H
Final actuation device(s) necessary to prevent hazard:	ESDV-011B, ESDV-104, 204, 304 & 404 close
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	MD	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	3	**2**	**1**
Other Protection Systems:	PSV-007B (to be uprated for full flow compressor suction drums) and PSV-006		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**1**	**0**	**0**
Overall Integrity Required:	**1**		
Consequences of Spurious Trip	Loss of production for a shift.		

	Assumptions:
1	
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3	
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		20

Trip:	80-LIT-021B LL		
System No. / Name:	Condensate Drums and Pumps		
P&ID No:	12254		
Role of protection function:	To prevent condensate export to the produced water treatment package and ultimately gas blow-by		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of interface level control.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Condensate flowing into the degasser and from there into the API separator and potentially into the evaporation pond. Potential for flashed gas release into the degasser and major discharge of flammable gas from the cold vent. Potenial for injury for personnel if ignites, reportable enviromental release. Loss of a proportion of the produced condensate
Functional requirements necessary to prevent hazard:	Isolate the water outlet from the condensate suction drum.
Process condition detected by 80-LIT-021B LL	80-LIT-021B LL, 80-LIC-016B L
Final actuation device(s) necessary to prevent hazard:	ESDV-026B
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:	API separator downstream of the degassers will recover some of the condensate.		
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	Water will carry over into the condensate and be exported into the pipelines, causing increased corrosion, see 80-LI-104 HH		

	Assumptions:
1	
2	
3	
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		21

Trip:	80-PI-070A LL		
System No. / Name:	Flash Gas Compression		
P&ID No:	12261		
Role of protection function:	To protect the flash gas compressor from low suction pressure.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	ESDV-012A/B fail closed	L	Low 3 - 30 yrs
2	Failure of 80-PIC-003	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the flash gas compressor. No loss in production as there is a spare compressor. Cost of repair of the compressor. Slight risk of injury of personnel and impact on the enviroment.
Functional requirements necessary to prevent hazard:	Trip the compressor
Process condition detected by 80-PI-070A LL	80-PI-070A LL, 80-PIC-003 L
Final actuation device(s) necessary to prevent hazard:	Compressor trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	Short term loss of gas to flare until stand by flash gas compressor is started.		

Assumptions:	
1	
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Recommendations	
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	Qasr SIL Assessment Worksheet Number:		22

Trip:	80-PIT-021A HH		
System No. / Name:	Flash Gas Compression		
P&ID No:	12261		
Role of protection function:	To trip the flash compressor and protect the discharge piping from over pressure		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Blocked discharge	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Over pressure the discharge piping, loss of containment, injury to personnel and impact to the enviroment. Loss of gas to the flare and cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-PIT-021A HH	80-PIT-021A HH, 80-PA-020A H
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:	PSV-022A sized for blocked discharge.		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	Short term loss of gas to flare until stand by compressor starts.		

	Assumptions:
1	
2	
3	
4	

	Recommendations
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3	
4	

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	Qasr SIL Assessment Worksheet Number:		23

Trip:	80-TIT-004A HH
System No. / Name:	Flash Gas Compression
P&ID No:	12261
Role of protection function:	To trip the compressor and to protect discharge piping from high temperature.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Blocked discharge	L	Low 3 - 30 yrs
2	High temperature gas from upstream	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Exceed the design temperature of the discharge piping, loss of containment, injury to personnel and impact to the enviroment. Loss of gas to the flare and cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-TIT-004A HH	80-TIT-004A HH, 80-TI-003A H
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	<M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Short term loss of gas to flash until stand by compressor starts.

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		24

Trip:	80-VIT-001A-HH
System No. / Name:	Flash Gas Compression
P&ID No:	12261
Role of protection function:	To trip the compressor at high compressor vibration and prevent damage to the compressor

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Compressor running out of balance, due to bearing failure, liquid carry-over or other similar causes.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the compressor, loss of containment. Minor risk of injury to personnel and impact to the enviroment. No loss of production, only cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-VIT-001A-HH	80-VIT-001A-HH (requires a pre-alarm)
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip system
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Short term loss of gas to flare until stand by compressor is started up by the operator.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		25

Trip:	80-TIT-002A HH		
System No. / Name:	Flash Gas Compression		
P&ID No:	12261		
Role of protection function:	To trip the compressor at high compressor bearing temperature and prevent damage to the compressor.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of the bearing	L	Low 3 - 30 yrs
2	Failure of the lubrication system.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the compressor, loss of containment. Minor risk of injury to personnel and impact to the enviroment. No loss of production, only cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-TIT-002A HH	80-TIT-002A HH (requires a pre-alarm)
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip system
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	Short term loss of gas to flare until operator starts up stand by flash gas compressor		

Assumptions:	
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Recommendations	
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	Qasr SIL Assessment Worksheet Number:		26

Trip:	80-PIT-070B LL
System No. / Name:	Flash Gas Compression
P&ID No:	12262
Role of protection function:	To protect the flash gas compressor from low suction pressure.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	ESDV-012A/B fail closed	L	Low 3 - 30 yrs
2	Failure of PIC-003	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the flash gas compressor. No loss in production as there is a spare compressor. Cost of repair of the compressor. Slight risk of injury of personnel and impact on the enviroment.
Functional requirements necessary to prevent hazard:	Trip the compressor
Process condition detected by 80-PIT-070B LL	80-PI-070B LL, 80-PIC-003 L
Final actuation device(s) necessary to prevent hazard:	Compressor trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	Short term loss of gas to flare until stand by flash gas compressor is started.		

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		27

Trip:	80-PIT-021B HH
System No. / Name:	Flash Gas Compression
P&ID No:	12262
Role of protection function:	To trip the flash compressor and protect the discharge piping from over pressure

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Blocked discharge	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Over pressure the discharge piping, loss of containment, injury to personnel and impact to the enviroment. Loss of gas to the flare and cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-PIT-021B HH	80-PIT-021B HH, 80-PA-020B H
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	<M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:	PSV-022B sized for blocked discharge.		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	Short term loss of gas to flare until stand by compressor starts.		

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		28

Trip:	80-TIT-004B HH
System No. / Name:	Flash Gas Compression
P&ID No:	12262
Role of protection function:	To trip the compressor and to protect discharge piping from high temperature.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Blocked discharge	L	Low 3 - 30 yrs
2	High temperature gas from upstream	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Exceed the design temperature of the discharge piping, loss of containment, injury to personnel and impact to the enviroment. Loss of gas to the flare and cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-TIT-004B HH	80-TIT-004B HH, 80-TI-003B H
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	<M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Short term loss of gas to flash until stand by compressor starts.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		29

Trip:	80-VIT-001B HH		
System No. / Name:	Flash Gas Compression		
P&ID No:	12262		
Role of protection function:	To trip the compressor at high compressor vibration and prevent damage to the compressor		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Compressor running out of balance, due to bearing failure, liquid carry-over or other similar causes.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the compressor, loss of containment. Minor risk of injury to personnel and impact to the enviroment. No loss of production, only cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-VIT-001B HH	80-VIT-001B-HH (requires a pre-alarm)
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip system
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Short term loss of gas to flare until stand by compressor is started up by the operator.

Assumptions:	
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Recommendations	
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	Qasr SIL Assessment Worksheet Number:		30

Trip:	80-TIT-002B HH
System No. / Name:	Flash Gas Compression
P&ID No:	12262
Role of protection function:	To trip the compressor at high compressor bearing temperature and prevent damage to the compressor.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Failure of the bearing	L	Low 3 - 30 yrs
2	Failure of the lubrication system.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the compressor, loss of containment. Minor risk of injury to personnel and impact to the enviroment. No loss of production, only cost of repair.
Functional requirements necessary to prevent hazard:	Trip the flash gas compressor
Process condition detected by 80-TIT-002B HH	80-TIT-002B HH (requires a pre-alarm)
Final actuation device(s) necessary to prevent hazard:	Flash gas compressor trip system
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	<M	RR
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Short term loss of gas to flare until operator starts up stand by flash gas compressor

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		31

Trip:	80-PIT-062 HH
System No. / Name:	Flash Gas Compression
P&ID No:	12262
Role of protection function:	To protect the flash gas compression system from potential over pressurisation due to reverse flow from process gas compressors suction.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Process gas compressor suction manifold is packed to pressure above 72 barg.	H	High 0.3 - 3yrs
2			
3			
4			
5			

Consequence: With no protection.	Mechanical damage to the flash gas compressor, over pressure of the flash gas compressor suction and discharge piping and condensate suction drums. Otential for the major release of hydrocarbons leading to fire explosion, multiple deaths and major impact on the enviroment. Loss of production for an extended period.
Functional requirements necessary to prevent hazard:	Isolate the route into the main compressor suction manifold.
Process condition detected by 80-PIT-062 HH	80-PIT-062 HH, 80-PI-072 H
Final actuation device(s) necessary to prevent hazard:	ESDV-013
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	MD	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	H	H	H
Integrity Required	**SIL**	**AIL**	**EIL**
	4	**3**	**2**
Other Protection Systems:	PSV-026 A/B sized for reverse flow.		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**2**	**1**	**0**
Overall Integrity Required:	**2**		
Consequences of Spurious Trip	Blocked discharge from the flash gas compressor and short term loss of gas to flare.		

Assumptions:

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4	

Recommendations

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	Qasr SIL Assessment Worksheet Number:		32

Trip:	80-PIT-075 LL 1
System No. / Name:	Air and Nitrogen Systems
P&ID No:	12300
Role of protection function:	To isolate the plant air supply in order to maintain the instrument air supply as long as possible

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Loss of intrument compression capacity	L	Low 3 - 30 yrs
2	Excessive consumption of air.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Loss of instrument air pressure causing ESD 2 shut down.
Functional requirements necessary to prevent hazard:	Isolate the supply to plant air.
Process condition detected by 80-PIT-075 LL 1	80-PIT-075 LL 1
Final actuation device(s) necessary to prevent hazard:	ESDV-015
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	No plant air available to utility points.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		33

Trip:	80-PIT-075 LL 2
System No. / Name:	Air and Nitrogen Systems
P&ID No:	12300
Role of protection function:	To isolate the nitrogen generator air supply in order to maintain the instrument air supply as long as possible

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Loss of intrument compression capacity	L	Low 3 - 30 yrs
2	Excessive consumption of air or nitrogen.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Loss of instrument air pressure causing ESD 2 shut down.
Functional requirements necessary to prevent hazard:	Isolate the air supply to the nitrogen generator.
Process condition detected by 80-PIT-075 LL 2	80-PIT-075 LL 2
Final actuation device(s) necessary to prevent hazard:	ESDV-016
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Lose nitrogen generation but the inert gas receiver has an eight hour inventory of nitrogen.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		34

Trip:	50-PIT-079 A/B/C LL
System No. / Name:	Air and Nitrogen Systems
P&ID No:	12315
Role of protection function:	To allow controlled shut down of the plant whilst there is still sufficient inventory of instrument air to allow this to occur.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Loss of instrument air supply	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Uncontrolled shut down of the plant.
Functional requirements necessary to prevent hazard:	ESD 2 shut down of plant.
Process condition detected by 50-PIT-079 A/B/C LL	50-PIT-079 A/B/C LL, 80-PIT-081 L
Final actuation device(s) necessary to prevent hazard:	ESD 2 shut down
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		<M	RR
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Loss of production for one shift (this is a 2 out of 3 initiation to minimise the likelyhood of a spurious trip)

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		35

Trip:	80-PIT-085 LL
System No. / Name:	Air and Nitrogen Systems
P&ID No:	12316
Role of protection function:	To isolate non-essential users to protect supply to essential users (compressors)

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Loss of nitrogen generator capacity	L	Low 3 - 30 yrs
2	Excessive demand for nitrogen	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	The supply to the essential consumers will not last eight hours and compressors have to be shut down. No risk to personnel or the enviroment.
Functional requirements necessary to prevent hazard:	Isolate the supply to non essential users.
Process condition detected by 80-PIT-085 LL	80-PIT-085 LL, 80-PIC-086 L
Final actuation device(s) necessary to prevent hazard:	ESDV-024
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Flash gas compressors will trip with loss of gas to the flare and charging and discharging operations on the MRU will be holted.

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		36

Trip:	80-LIT-005 LL		
System No. / Name:	Fuel Gas System		
P&ID No:	12305		
Role of protection function:	Prevent gas blow by from HP Fuel Gas KO drum to the closed drains drum.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Level control failure	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Loss of gas to the cold vent. No risk to personnel, enviromental impact and cost of the lost gas.
Functional requirements necessary to prevent hazard:	Isolate the liquid outlet from the HP fuel gas KO drum.
Process condition detected by 80-LIT-005 LL	80-LIT-005 LL, 80-LIC-006 L
Final actuation device(s) necessary to prevent hazard:	Close ESDV-005
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		<M	RR
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Normally no liquid. If liquid carries over can damage the MRU bed and the fuel gas heater, compressors may trip if the filters block with

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		37

Trip:	80-LIT-005 HH
System No. / Name:	Fuel Gas System
P&ID No:	12305
Role of protection function:	To prevent liquid carry over into the Mercury Removal Unit and downstream equipment.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Failure of level control.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Normally no liquid. If liquid carries over can damage the MRU bed and the fuel gas heater, compressors may trip if the filters block with dust from the MRU.
Functional requirements necessary to prevent hazard:	Isolate all the incoming streams to the HP fuel gas
Process condition detected by 80-LIT-005 HH	80-LIT-005 HH, 80-LIC-006 H
Final actuation device(s) necessary to prevent hazard:	ESDV-002A/B, ESDV-003 A/B, ESDV-004 A/B, ESDV-010 A/B, ESDV-028 A/B will close.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Short term outage for one shift when compressors trips.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		38

Trip:	80-PIT-004 HH		
System No. / Name:	Fuel Gas System		
P&ID No:	12305		
Role of protection function:	To prevent overpressure of HP fuel gas system		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Pressure control failure	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential to exceed to design pressure of HP fuel gas system, loss of containments leading to fire explosion, enviromental impact and extended loss of production.
Functional requirements necessary to prevent hazard:	Trip all incoming gas flows to HP fuel gas.
Process condition detected by 80-PIT-004 HH	80-PIT-004 HH, 80-PIC-043 H
Final actuation device(s) necessary to prevent hazard:	ESDV-002A/B, ESDV-003 A/B, ESDV-004 A/B, ESDV-010 A/B, ESDV-028 A/B will close.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	MD	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	3	**2**	**1**
Other Protection Systems:	PSV-097 A/B sized for control valve failure.		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**1**	**0**	**0**
Overall Integrity Required:	**1**		
Consequences of Spurious Trip	Loss of fuel gas, compressors trip, short term losss of production for one shift.		

Assumptions:	
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Recommendations	
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	Qasr SIL Assessment Worksheet Number:		39

Trip:	80-PIT-004 LL
System No. / Name:	Fuel Gas System
P&ID No:	12305
Role of protection function:	To trip the compressors and power generators at low fuel gas pressure.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	**Event Frequency**	
1	Failure of pressure control	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Lose fuel gas to the compressors and generators causing an ESD 2 shut down. No risk to personnel and the enviroment. No major commericial consequences because individual compressor and generator drives will trip on local low fuel gas pressure.
Functional requirements necessary to prevent hazard:	Isolate HP fuel gas to consumers.
Process condition detected by 80-PIT-004 LL	80-PIT-004 LL, 80-PIC-043 L
Final actuation device(s) necessary to prevent hazard:	Compressor trip and generator change over to diesel.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences			
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)			
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	No significant consequences.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		40

Trip:	80-TIT-007 HH
System No. / Name:	Fuel Gas System
P&ID No:	12302
Role of protection function:	Prevent over heating of flash gas to HP fuel gas feed.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	**Event Frequency**	
1	Contacts on flash gas preheater fused.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential to exceed design temperature of downstream piping leading to loss of containment, injury to personnel, enviromental impact and cost of repair. No loss of production.
Functional requirements necessary to prevent hazard:	Isolate the power to flash gas preheater.
Process condition detected by 80-TIT-007 HH	80-TIT-007 HH, 80-TDIC-008 H
Final actuation device(s) necessary to prevent hazard:	Power supply to heater.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	No significant consequences.

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		41

Trip:	80-TIT-005 HH
System No. / Name:	Fuel Gas System
P&ID No:	12302
Role of protection function:	To protect the heater elements from over heating.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Failure of the temperature control	L	Low 3 - 30 yrs
2	Fused contacts.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Potential burnout of the heater elements, loss of containment, local fire, risk of injury to personnel, minor impact to the enviroment and cost to repair. Potential for fire to be confirmed causing ESD 1 shut down which includes automatic blow down.
Functional requirements necessary to prevent hazard:	Isolate the power supply to the heater.
Process condition detected by 80-TIT-005 HH	80-TIT-005 HH, 80-TDIC-008 H
Final actuation device(s) necessary to prevent hazard:	Heater trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	MM	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	No significant consequence

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		42

Trip:	80-FI-XXX LL
System No. / Name:	Fuel Gas System
P&ID No:	12302
Role of protection function:	Prevent over heating of flash gas to HP fuel gas feed.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	**Event Frequency**	
1	Failure of the flow control	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential to exceed design temperature of downstream piping leading to loss of containment, injury to personnel, enviromental impact and cost of repair. No loss of production.
Functional requirements necessary to prevent hazard:	Isolate the power to flash gas preheater.
Process condition detected by 80-FI-XXX LL	80-FI-XXX LL
Final actuation device(s) necessary to prevent hazard:	Power supply to heater.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	<M	RR
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	No significant consequences.

Assumptions:

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Recommendations

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GENESIS	Qasr SIL Assessment Worksheet Number:		43

Trip:	80-TIT-011 HH		
System No. / Name:	Fuel Gas System		
P&ID No:	12302		
Role of protection function:	To protect the piping downstream of the HP fuel gas preheater and the HP fuel gas KO drum from over heating		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of temperature control	L	Low 3 - 30 yrs
2	Fused contacts.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Exceed the design temperature of the downstream piping and the HP fuel gas KO drum. Loss of containment leading to fire explosion, injury to personnel, enviromental impact and extended loss of production.
Functional requirements necessary to prevent hazard:	Trip the HP fuel gas preheater.
Process condition detected by 80-TIT-011 HH	80-TIT-011 HH, 80-TDIC-012 H
Final actuation device(s) necessary to prevent hazard:	Heater trip.
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	1D	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	2	**2**	**1**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**2**	**2**	**1**
Overall Integrity Required:	**2**		
Consequences of Spurious Trip	Liquid dropout in the HP KO drum, no loss of production.		

	Assumptions:
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	Recommendations
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GENESIS	Qasr SIL Assessment Worksheet Number:		44

Trip:	80-TIT-009 HH		
System No. / Name:	Fuel Gas System		
P&ID No:	12302		
Role of protection function:	To protect the heater elements from over heating.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of the temperature control	L	Low 3 - 30 yrs
2	Fused contacts	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Potential burnout of the heater elements, loss of containment, local fire, risk of injury to personnel, minor impact to the enviroment and cost to repair. Potential for fire to be confirmed causing ESD 1 shut down which includes automatic blow down.
Functional requirements necessary to prevent hazard:	Isolate power to the heater
Process condition detected by 80-TIT-009 HH	80-TIT-009 HH, 80-TDIC-012 H
Final actuation device(s) necessary to prevent hazard:	Heater trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels			
	Safety	**Financial loss**	**Environmental Loss**
Consequences	1D	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	2	**2**	**1**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**2**	**2**	**1**
Overall Integrity Required:	**2**		
Consequences of Spurious Trip	Liquid dropout in the HP KO drum, no loss of production. MRU may be damaged by saturated gas causing liquid condensation on the		

Assumptions:	
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Recommendations	
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	Qasr SIL Assessment Worksheet Number:		45

Trip:	80-TIT-022A HH, 08-TIT-022B HH
System No. / Name:	Fuel Gas System
P&ID No:	12307
Role of protection function:	To trip the HP fuel gas heater and protect the HP and LP fuel gas systems from excessively high temperatures

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	**Event Frequency**	
1	Temperature control failure	L	Low 3 - 30 yrs
2	Fused contacts	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	Potential to exceed the design temperature of the HP and LP fuel gas systems leading to loss of containment with potential fatality, enviromental impact and minimum of f sevral days loss of production.
Functional requirements necessary to prevent hazard:	Isolate the power to the heater.
Process condition detected by 80-TIT-022A HH, 08-TIT-022B HH	80-TIT-022A HH, 80-TIT-022B HH, 80-TDIC-020A H
Final actuation device(s) necessary to prevent hazard:	Heater trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	1D	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	2	**2**	**1**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**2**	**2**	**1**
Overall Integrity Required:	**2**		
Consequences of Spurious Trip	Loss of superheat in fuel gas supply to turbines, which may trip on low absolute temperature.		

Assumptions:

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Recommendations

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GENESIS	Qasr SIL Assessment Worksheet Number:		46

Trip:	80-TIT-019A HH, 80-TIT-019B HH		
System No. / Name:	Fuel Gas System		
P&ID No:	12307		
Role of protection function:	To cut the power supply in the event of thermal overload to the heater.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Fused coontacts	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential burnout of the heater elements, loss of containment, local fire, risk of injury to personnel, minor impact to the enviroment and cost to repair. Potential for fire to be confirmed causing ESD 1 shut down which includes automatic blow down.
Functional requirements necessary to prevent hazard:	Isolate power to heaters.
Process condition detected by 80-TIT-019A HH, 80-TIT-019B HH	80-TIT-019A HH, 80-TIT-019B HH
Final actuation device(s) necessary to prevent hazard:	Heater trip
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**1**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**1**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Loss of superheat in fuel gas supply to turbines, which may trip on low absolute temperature.

	Assumptions:
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	Recommendations
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	Qasr SIL Assessment Worksheet Number:		47

Trip:	80-TDI-XXX LL
System No. / Name:	Fuel Gas System
P&ID No:	12307
Role of protection function:	To protect the gas turbines from non superheated gas

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Temperature control failure.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Turbines will see non superheated gas and potential mechanical damage. Extended loss of production
Functional requirements necessary to prevent hazard:	Trip the turbines
Process condition detected by 80-TDI-XXX LL	80-TDI-XXX LL, 80-TDIC-020A/B L
Final actuation device(s) necessary to prevent hazard:	Turbine trips
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		>M	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**2**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**2**	**0**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Short term loss of production

Assumptions:

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Recommendations

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	Qasr SIL Assessment Worksheet Number:		48

Trip:	80-LIT-008 LL
System No. / Name:	Fuel Gas System
P&ID No:	12308
Role of protection function:	Prevent gas blow by from LP Fuel Gas KO drum to the closed drains drum

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Failure of level control	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Loss of LP fuel gas to cold vent. No risk to personnel, minor enviromental impact and cost of the lost gas.
Functional requirements necessary to prevent hazard:	Isolate the liquid outlet from the LP fuel gas KO drum.
Process condition detected by 80-LIT-008 LL	80-LIT-008 LL, 80-LIC-009 L
Final actuation device(s) necessary to prevent hazard:	ESDV-006
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences		<M	RR
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	Normally no liquid, but if liquid carries over, will extinguish the flare gas pilots.

Assumptions:

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Recommendations

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Trip:	80-PIT-053 LL
System No. / Name:	Fuel Gas System
P&ID No:	12308
Role of protection function:	To open the back-up fuel gas supply to essential users (flare pilots and purges) if the LP fuel gas supply is lost.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Loss of gas from the HP fuel gas supply.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Loss of LP fuel gas to consumers which include purges to the flares and vents, pilot gas supply.
Functional requirements necessary to prevent hazard:	Open the back-up fuel gas supply.
Process condition detected by 80-PIT-053 LL	80-PIT-053 LL, 80-PIC-054 L
Final actuation device(s) necessary to prevent hazard:	Opens ESDV-025 A
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences			
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)			
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	No significant consequences

Assumptions:

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Recommendations

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Trip:	80-PIT-053 HH		
System No. / Name:	Fuel Gas System		
P&ID No:	12308		
Role of protection function:	To protect the LP fuel gas knock out drum.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of pressure control	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Over pressure of the LP fuel gas KO drum leading to loss of containments, potential fatality enviromental impact and extended shut down until damage is repaired.
Functional requirements necessary to prevent hazard:	Isolated the HP fuel gas let down.
Process condition detected by 80-PIT-053 HH	80-PIT-053 HH, 80-PIC-054 H
Final actuation device(s) necessary to prevent hazard:	ESDV-007
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	1D	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	2	**2**	**1**
Other Protection Systems:	PSV-055 A/B sized for control valve failure.		
Integrity reduction (other protection)	2	2	2
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**
Overall Integrity Required:	**0**		
Consequences of Spurious Trip	No significant consequences because back up supply will make up for short fall		

Assumptions:

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Recommendations

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Trip:	80-LIT-008 HH		
System No. / Name:	Fuel Gas System		
P&ID No:	12308		
Role of protection function:	To prevent liquid carry into the LP fuel gas distribution system.		
Hazard Assessment Process:			
SIL MEETING	Team:	See Attendance List	
	Date:	03/10/2011	

	Events leading to the hazard	**Event Frequency**	
1	Failure of the level control	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Liquid in the LP fuel gas distribution system will extinguish the flare pilots.
Functional requirements necessary to prevent hazard:	ESD 2 shutdown
Process condition detected by 80-LIT-008 HH	80-LIT-008 HH, 80-LIC-009 H
Final actuation device(s) necessary to prevent hazard:	ESD 2 shutdown
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences		MM	
Exposure Time (R or F)			
Avoidance Probability (P or NL)			
Demand Rate (H, L, or VL)		L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**0**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	Loss of production for a shift.
Assumptions:	
1	
2	
3	
4	
Recommendations	
1	
2	
3	
4	

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	1	

	Qasr SIL Assessment Worksheet Number:		52

Trip:	65-LIT-002 LL
System No. / Name:	Closed Drain System
P&ID No:	12311/12314
Role of protection function:	Protect closed drains drum pump

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Closed drain pump fails to stop and closed drain transfer pump fails to stop.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Potential to damage the pumps, loss of containment, injury to personnel. No loss of production.
Functional requirements necessary to prevent hazard:	Trip the drain drum and drains transfer pump
Process condition detected by 65-LIT-002 LL	65-LIT-002 LL, 80-PIC-012 L
Final actuation device(s) necessary to prevent hazard:	Pump trips
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	SI	<M	
Exposure Time (R or F)	R		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**0**	**0**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**0**	**0**

Overall Integrity Required:	**0**
Consequences of Spurious Trip	

Assumptions:

1	
2	
3	
4	

Recommendations

1	
2	
3	
4	

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	Qasr SIL Assessment Worksheet Number:		53

Trip:	65-LIT-002 HH
System No. / Name:	Closed Drain System
P&ID No:	12305
Role of protection function:	To prevent the closed drains drum overflowing into the cold vent and not to allow the plant to operate when the closed drain drum is full

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	**Event Frequency**	
1	Drum or transfer pump fails to start.	L	Low 3 - 30 yrs
2			
3			
4			
5			

Consequence: With no protection.	Over flow into the cold vent system, potential to discharge hydrocarbon from vent. Enviromental impact, loss of production for one shift to remedy the situation.
Functional requirements necessary to prevent hazard:	ESD 2 shutdown
Process condition detected by 65-LIT-002 HH	65-LIT-002 HH, 80-LIC-012 H
Final actuation device(s) necessary to prevent hazard:	ESD 2 shutdown
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	**Financial loss**	**Environmental Loss**
Consequences	SI	MM	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	0	**1**	**1**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**0**	**1**	**1**

Overall Integrity Required:	**1**
Consequences of Spurious Trip	ESD 2 shutdown, causing one shift loss of production.

Assumptions:

1	
2	
3	
4	

Recommendations

1	
2	
3	
4	

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	1	

	Qasr SIL Assessment Worksheet Number:		54

Trip:	30-LIT-344 HH
System No. / Name:	Flare
P&ID No:	12356
Role of protection function:	To shut the plant down if the is high level in the flare KO drum.

Hazard Assessment Process:

SIL MEETING	Team:	See Attendance List
	Date:	03/10/2011

	Events leading to the hazard	Event Frequency	
1	Large liquid discharges to existing flare from existnig facilities or compression facilities.	L	Low 3 - 30 yrs
2	Inability to evacutate liquid from existing flare drum.	L	Low 3 - 30 yrs
3			
4			
5			

Consequence: With no protection.	High back pressure from the flare system and golden rain from the flare. Extended shutdown to clear the problem. Potential for multiple deaths.
Functional requirements necessary to prevent hazard:	ESD 2 shutdown
Process condition detected by 30-LIT-344 HH	30-LIT-344 HH, 30-LI-344 H
Final actuation device(s) necessary to prevent hazard:	ESD 2 shutdown
Functional requirements for orderly shutdown and start-up:	None Specified

Method of Determining required integrity levels

	Safety	Financial loss	Environmental Loss
Consequences	1D	>M	MT
Exposure Time (R or F)	F		
Avoidance Probability (P or NL)	NL		
Demand Rate (H, L, or VL)	L	L	L
Integrity Required	**SIL**	**AIL**	**EIL**
	2	**2**	**1**
Other Protection Systems:			
Integrity reduction (other protection)			
Integrity reduction (assumptions)			
Revised integrity required	**2**	**2**	**1**

Overall Integrity Required:	**2**
Consequences of Spurious Trip	Loss of a shifts production to recover.

Assumptions:

1	
2	
3	
4	

Recommendations

1	
2	
3	
4	

Document No.	Sheet No.	Sheet Revision:
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APPENDIX B – HAZOP MASTER P&IDS

Appendix B_Hazop Marked Up P&IDs.pdf

APPENDIX C – MASTER ESD CAUSE & EFFECTS DIAGRAM

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0 Rev C1 ESD Cause